TAP 225- 2: Centripetal force calculations

1. A space station has a radius of 100 m and is rotated with an angular velocity of 0.3 radians per second.

(i) Which side of a "room" at the rim is the floor?

(ii) What is the artificial gravity produced at the rim?

2. The wire is 1.5 m long has a mass of 7.5 kg fixed to its end and can withstand a maximum tension of 1000 N. What is the maximum angular velocity and period of rotation with which the wire and mass can be spun round in a horizontal circle without the wire snapping?

3. Calculate the rate of rotation for a space station of radius 65 m so that astronauts at the outer edge experience artificial gravity equal to 9.8 m s^{-2}.

Answers and Worked Solutions

1. (i) The floor is the outer rim of the space station since it is this side that is pushing the astronaut out of a straight line path and towards the centre of the circle.

   (ii) $a = g = \omega^2 r = 0.32 \times 100 = 9 \text{ m s}^{-2}$

2. $F = m\omega^2 r$ and so $\omega = \sqrt{(Fr/m)}$

   Angular velocity $(\omega) = \sqrt{(1000 \times 1.5 / 7.5)} = 14.1 \text{ rad s}^{-1}$

   Period $(T) = 2\pi / \omega = 2\pi / 14.1 = 0.45 \text{ s}$

3. Using $a = g = v^2/r$ we have $a = g = 9.8 = v^2/65$ and so $v = 25.2 \text{ m s}^{-1}$.

   But $T = 2\pi r/v$ and so $T = 16.18$ s giving the rotation rate $(1/T)$ as 0.062 Hz.

External References

This activity is taken from Resourceful Physics http://resourcefulphysics.org/